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# MULTIMEDIA UNIVERSITY

## FINAL EXAMINATION

TRIMESTER 2, 2015/2016

**EEL4106 – HIGH VOLTAGE ENGINEERING**  
( LE )

8 MARCH 2016  
9.00 a.m – 11.00 a.m  
(2 Hours)

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### INSTRUCTIONS TO STUDENT

1. This question paper consists of 3 pages including the cover page with 4 Questions only.
  2. Answer **ALL** questions. The distribution of the marks for each question is given.
  3. Please write all your answers in the Answer Booklet provided.
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**Question 1**

- (a) With proper labelling, draw the voltage doubler circuit suggested by Greinacher to obtain  $2V_m$ . [4 Marks]
- (b) A Cockcroft-Walton voltage multiplier has 10 stages with capacitances, all equal to  $0.03 \mu\text{F}$ . The supply transformer secondary voltage is  $130 \text{ kV}$  at a frequency of  $150 \text{ Hz}$ . If the load current is  $5 \text{ mA}$ , find  
 (i) The percentage ripple, and [4 Marks]  
 (ii) The percentage regulation. [4 Marks]
- (c) Briefly explain TWO advantages of resonant transformer [3 Marks]
- (d) The elements of the circuit shown in Figure Q1(d) for producing lightning impulse voltages are  $C_1 = 10 \mu\text{F}$ ,  $C_2 = 40 \text{ pF}$ ,  $R_1 = 2 \text{ k}\Omega$ ,  $R_2 = 8 \text{ k}\Omega$ . Obtain  $\alpha$  and  $\beta$  to be used in the equation  $v_o(t) = \frac{V}{R_1 C_2} (e^{-\alpha t} - e^{-\beta t}) \text{ kV}$  [10 Marks]

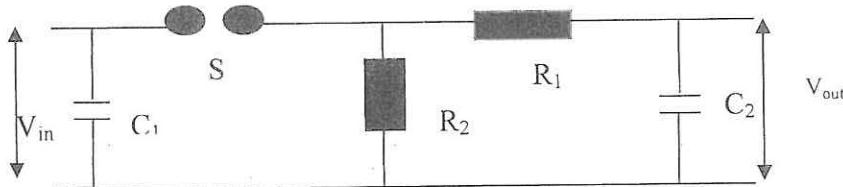


Figure Q1(d)

**Question 2**

- (a) List out ONE advantage and TWO disadvantages of uniform field electrode gaps. [3 Marks]
- (b) An electrostatic voltmeter has a movable circular plate with cross-sectional area of  $100 \text{ cm}^2$ . If the distance between the plates during a measurement is  $5 \text{ mm}$ , determine the potential difference when the force of attraction is  $0.005 \text{ N}$ . [4 Marks]
- (c) Draw a Schering bridge circuit to determine the loss factor of a specimen and derive the necessary expressions. An insulation specimen is tested at  $50 \text{ Hz}$  using the Schering Bridge. The bridge has a standard capacitor,  $C_s$  of  $100 \text{ pF}$ , a non-inductive resistor,  $R_4$  of  $500 \Omega$  in parallel with a variable capacitance  $C_4$ , and a non-inductive variable resistor  $R_3$ . If balance is obtained with  $C_4 = 0.25 \mu\text{F}$  and  $R_3 = 150 \Omega$ , determine the loss factor, capacitance and resistance of the specimen using series equivalent model. [12 Marks]
- (d) Briefly explain the following terms as applied to high voltage testing.  
 (i) Withstand voltage [2 Marks]  
 (ii) 50% impulse flashover voltage [2 Marks]  
 (iii) Disruptive discharge voltage [2 Marks]

Continued...

**Question 3**

(a) Briefly explain the term ‘breakdown’ as used to describe breakdown in gaseous medium, and list out TWO mechanisms that explain the breakdown of gaseous medium under a static uniform field. [3+2 Marks]

(b) Figure Q3 shows the void in the solid dielectric material, where  $t$  is the thickness of the cavity, and  $d$  is the thickness of the solid dielectric material.

(i) Draw the equivalent circuit of a dielectric material with a cavity [3 Marks]

(ii) Derive expressions for the capacitance of the cavity,  $C_c$ , and solid dielectric material,  $C_s$ . [4 Marks]

(iii) Show that if a voltage  $V$  is applied across the dielectric, then the voltage

$$\text{across the cavity } V_v = \frac{V}{1 + \frac{1}{\epsilon_r} \left( \frac{d}{t} - 1 \right)}, \text{ where } \epsilon_r \text{ is the relative permittivity.}$$

[7 Marks]

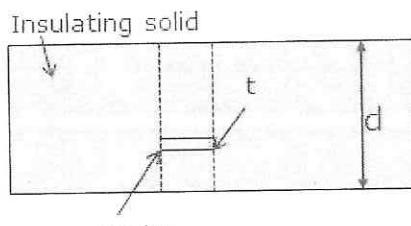


Figure Q3

(c) The breakdown of a certain gas occurs at a uniform electric field between two plane electrodes having a spacing of 1.0 cm. If the Townsend’s second ionization coefficient  $\gamma$  is 0.001 find the value of the Townsend’s primary ionization coefficient  $\alpha$ . [6 Marks]

**Question 4**

(a) List out TWO advantages and TWO disadvantages of the rod gap (horn gap). [6 Marks]

(b) Draw the V-I curve of a surge arrester and briefly explain THREE conduction regions of V-I characteristics of the surge arrester. [8 Marks]

(c) A rectangular voltage wave of 3000 kV is traveling along a line of surge impedance  $300 \Omega$  towards a lightning arrester. The arrester protective level is 2000 kV and is assumed to be fairly constant at all current values discharged by the arrester. Calculate

(i) the current flowing through the line before the surge voltage reaches the arrester terminal, [2 Marks]

(ii) the current through the arrester, [2 Marks]

(iii) reflected current in the line,  $I_2$ , reflected voltage in the line,  $V_2$ , refracted voltage into the arrester,  $V_3$ , reflected coefficient of voltage and refraction coefficient of voltage, and [5 Marks]

(iv) the arrester’s resistance. [2 Marks]

**End of Paper.**